NOTES ON THE ALGAL GENUS TAENIOMA[1]

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The algal genus *Taenioma* (Delesseriaceae, Rhodophyceae) was founded by J. G. Agardh (2, p. 1256) on *Polysiphonia perpusilla* which he (1, p. 16) himself previously had described from material collected by Liebmann at St. Augustin on the Pacific coast of Mexico. The then monotypic genus was characterized by (1) a filiform, dichotomously branched frond with polysiphonous, articulate, noncorticate filaments; (2) the presence of marginal cells half the length of the segments on the flattened portion of the frond; and (3) dilated, vittiform stichidia bearing tetrasporangia (then known as sphaerospores) in a double series. The genus was placed by its author, together with *Sarcomenia,* in the tribe Sarcomeniae which was then placed in the family Rhodomelaceae but later more properly removed by Schmitz (19) to the Delesseriaceae.

Thuret (7, p. 69, pl. 25) added another species to the genus, namely *Taenioma macrourum,* citing as a synonym *Hutchinsia macroura* Schousboe in herb. The type material came from Tangier, Morocco, in the Mediterranean. Not having seen J. Agardh's specimen of *T. perpusillum* Thuret, in describing his species, expressed some doubt as to the specific difference between the Mediterranean form and the one from the Pacific. In keeping the two separate, he was probably influenced by the widely separated regions from which the two plants were collected, some apparent differences in size and color, and especially the presence in the Mediterranean plant of two apical hairs which were presumably absent in the alga from the Pacific. It should be noted, however, that J. Agardh, *op. cit.,* did mention the presence of apical hairs in his plant: "Stichidium . . . apice saepe in fila minuta 3 . . . excurrens." Examination of Agardh's type specimen by Howe (*in* Thompson, 21, p. 98) has confirmed this. The writer has also examined a fragment of the original specimen deposited in the herbarium of the New York Botanical Garden and is in perfect agreement with Howe.

Several years after the publication of *Taenioma macrourum* Thuret, Bornet (6, p. 297) examined a specimen of *T. perpusillum* J. Ag. and came to the conclusion that the Pacific and the Mediterranean plants are not separable specifically. Later, Heydrich (12, p. 295) and De-Toni (9, p. 732) adopted Bornet's view. Schmitz and Hauptfleisch (20, p. 415), however, retained both species. In his classical work on the Rhodomelaceae, Falkenberg (10, p. 709, pl. 15, fig. 21–29), devoted some space to the morphology of the Mediterranean plant, which he separated from the Pacific alga chiefly on the basis of its having long monosiphonous

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apical filaments on the flattened "leaves," presumably absent in *T. perpusillum* J. Agardh. This, as already pointed out above, is not correct. Falkenberg also mentioned that the two species differed in the nature of the branches. He remarked that in the Mediterranean plant the cylindrical segments of the side branches and also those of the axis between two branches were so short and compact that it was easily distinguishable from the Pacific plant, which was much slenderer and more loosely branched. While it is true that the Pacific alga has much longer side branches, the shortness and compactness of the segments are similar in both cases. It is no wonder, therefore, that later authors (cf. Collins and Hervey, 8, p. 117; Børgesen, 4, p. 341; and Okamura, 17, p. 26) in trying to differentiate the two species on this basis, could not see the desirability of keeping them apart.

Thompson (21) published a detailed study of the morphology of *Taenioma,* using two different sets of materials collected by Howe at Porto Rico (Puerto Rico) and at West Caicos in the Bahamas. She was probably the first to note some of the important differences between *T. perpusillum* and *T. macrourum* although she discussed both forms under the latter name. Such differences between these two collections as the branching and the number of apical hairs and segments in the flattened shoots have been correctly emphasized. In an editorial note in Thompson's paper, Howe justified that author's identification of the Bahamian plant with the Mediterranean species. He questioned, however, "the identity of this *T. macrourum* with the previously described *Taenioma perpusillum* of J. Agardh . . . ," remarked that his Puerto Rican plant and the type of J. Agardh's species from Mexico are "essentially the same except that the terminal hairs are much longer and more luxuriant in the Porto Rican plant," and concluded that he was "inclined to agree with Bornet . . . with Heydrich . . . and with De-Toni . . . in considering *Taenioma macrourum* (Schousb.) Thur. a synonym of *Taenioma perpusillum* J. Ag."

Howe seemed to have regarded the differences of these two sets of specimens, which he considered to belong to the same species, as a matter of ecological influence. He made the remark that the Bahamian plants "were found growing in an inland pond or lake, having evidently a subterranean communication with the sea—a place where several marine algae of recognizable species were more or less abnormal and peculiar," and the Puerto Rican plants "were growing where they were well exposed to the surge of the open sea." It should be noted, however, that Børgesen (4, p. 341), whose plant was evidently of the same species as Howe's from the Bahamas, found it "in an open place upon reefs of calcareous algae, etc."

To date, phycologists seem to have regarded this problem of the *Taenioma perpusillum-macrourum* complex as satisfactorily

settled, have generally adopted the view of Bornet and his followers, and have conventionally put *T. macrourum* as a synonym of *T. perpusillum* whenever that species is reported.

The third species of *Taenioma* was described by Farlow (11, p. 236) on material from San Diego, California, and was named *Taenioma Clevelandii.* As described, it "has scattered stichidia, is four inches high, and has a striking resemblance to *Griffithsia tenuis* Harv.," and its "stichidial branches terminate in a more or less acute apex instead of two hairs." It was also mentioned that "in the lower part of the frond, the angles between the primary cells are filled with a small but irregular number of secondary cells." All these peculiarities are certainly very different from the characteristics of the *Taenioma perpusillum-macrourum* complex and the writer has long doubted its being a member of this group. He has studied some specimens collected at Moss Beach, Pacific Grove, California (*Hollenberg 3228*) and is fully convinced that it should be separated from *Taenioma.*

Recently Hollenberg (13, p. 534) has pointed out several additional differences between *Taenioma Clevelandii* Farl. and *T. perpusillum* J. Ag., although he still preferred to keep the Californian plant in the same genus. Dr. Papenfuss who has made a critical study of *Taenioma Clevelandii* has agreed with the writer that it does not properly belong to *Taenioma.* He has further decided that it should be transferred to the genus *Platysiphonia* Børg., because (1) its branches are endogenous in origin; (2) it does not form terete branches; (3) it does not have determinate branches ending in hairs; and (4) its tetrasporangial branches have a dorsiventral organization, since the stalk cell of a tetrasporangium forms a large cover cell on one surface and a rudimentary one on the other. These characteristics are so fundamentally different from those of *Taenioma,* that there should no longer be doubt among phycologists that the plant from San Diego should be removed from the genus *Taenioma.*

Some years ago, the writer gathered from Hong Kong a collection of a *Taenioma* rich in tetrasporangia. At first, he was inclined to follow others and consider *T. macrourum* Thur. a synonym of *T. perpusillum* J. Ag. The more the specimens and literature were studied, however, the more hesitant he was to do so. After a thorough study of his collection, which has been preserved in excellent condition for microscopic examination, and the extensive collections of Howe, including some fragments of the type specimen of *T. perpusillum* J. Ag., deposited in the Herbarium of the New York Botanical Garden, the conclusion was finally arrived at, that the differences, especially those reported by Thompson and Howe, do exist, and are very constant. Other differences have also been found. The fact that the same form has been reported to occur in sheltered and exposed places and both forms in more or less similar situations naturally eliminates

the possibility of their being ecological forms, at least, so far as the factor of the relative exposure to surf is concerned. Furthermore, the geographical distribution of *T. perpusillum* and *T. macrourum* gives evidence of their distinctness. When fundamental differences between these two forms are constant and without intermediates, and when these cannot be traced to ecological or geographical influences, then there is no alternative than to accept the two forms as separate, independent species.

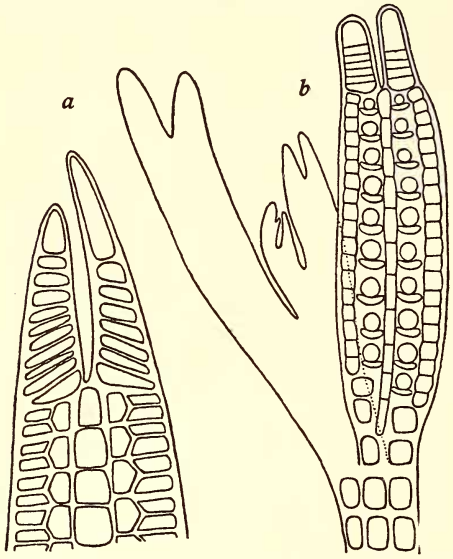

Fig. 1. *Taenioma macrourum* Thuret: *a*, apex of a branchlet showing the two apical hairs, ×560; *b*, upper part of a branch showing a stichidium, ×190.

The most important difference between the two lies in the number of apical hairs. The Puerto Rican and Hong Kong specimens always have three apical hairs on the flattened branchlets and are referable to *T. perpusillum* J. Ag. There are many determinate branchlets which at a glance seem to have only two hairs. A careful study, however, reveals the fact that the oldest hair in the group of three has already dropped off, and the two younger ones are left behind (pl. 25, fig. 5). The Bahamian, Bermudian, and Mediterranean specimens as well as the Japanese plants described and illustrated by Okamura (17, p. 26, pl. 244, fig. 17–19, pl. 245, fig. 5–9, on the contrary, have only two hairs and undoubtedly belong to *T. macrourum* (text fig. 1a). To be sure, Okamura (17, p. 27, pl. 265, fig. 8) mentioned and figured a branchlet with three apical hairs. Whether this was an abnormal form of the normally two-haired plant, or whether Okamura had both species, can be settled only by examination of his specimens which had come from at least two different sources.

The presence of two or of three such apical hairs is neither accidental nor irregular. It is rather a matter of fundamental difference traceable to the behavior of the apical cells of the determinate branchlets. In *T. macrourum,* the apical cell, after having formed the more or less definite number of segments, gives rise by an oblique division to a hair-initiating cell. Later, the apical cell itself assumes the role of hair formation, thus resulting in two hairs (text fig. 1a). In the case of *T. perpusillum,* the apical cell by alternate oblique divisions forms two hair-initials.

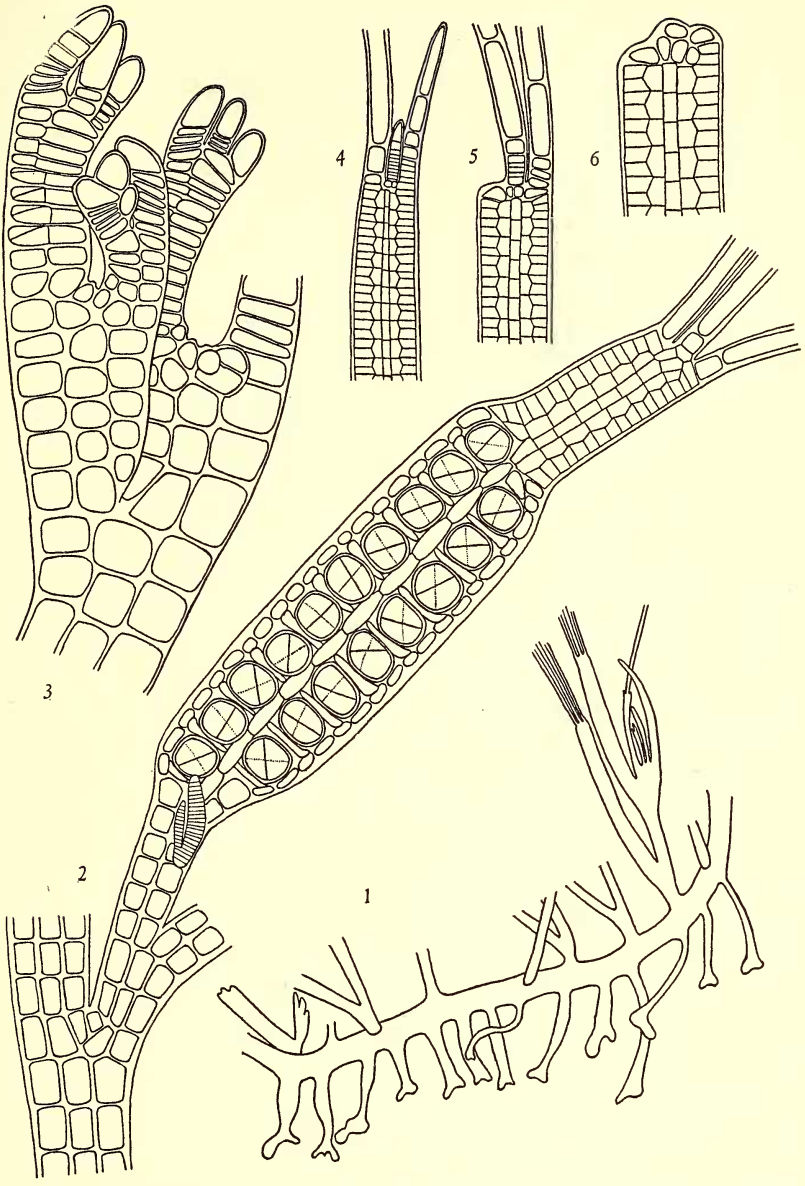

PLATE 25. TAENIOMA PERPUSILLUM (J. Agardh) J. Agardh. FIG. 1. Habit sketch of a portion of a young plant, ×32. FIG. 2. A part of an erect branch, showing a stichidium with tetrasporangia, the differentiation of fertile and sterile portions, and the apical hairs, ×155. FIG. 3. Apical part of a branch showing the apical cells, ×452. FIG. 4. A young branchlet with three hairs in different stages of development, ×155. FIG. 5. An older branchlet with one hair dropped off and two remaining, ×155. FIG. 6. An old branchlet with all three hairs dropped off, leaving three basal cells of the hairs behind, ×155.

One of these develops faster than the other, resulting in two hairs of unequal length. Later the apical cell also gives rise to a hair, resulting in the three terminal hairs characteristic of this species (pl. 25, figs. 2, 3 and 4). In the younger branchlets, while all three hairs are found, the central one generally remains shortest (pl. 25, fig. 4). In older branchlets, the first-formed lateral hair may have dropped off, leaving its basal cell in the original position, while the two which develop later, remain (pl. 25, fig. 5). Then, the other lateral hair and at last the central one drops off, leaving the three basal cells of the original hairs behind. The branchlet at this stage appears stunted, blunt and hairless at the apex (pl. 25, fig. 6). This explains why sometimes there appear to be only one or two hairs, or even hairless forms, instead of the three hairs as described.

Another important difference, already pointed out by Thompson, *op. cit.,* lies in the respective number of segments in the flattened determinate branchlets of these two species. In *T. perpusillum,* there are generally 20 to 35 segments, occasionally as few as 15, and the length of the mature branchlets varies from 0.6 to 1.0 mm. In *T. macrourum,* there are many fewer segments, generally 8 to 20 only, rarely more, and the branchlets are correspondingly shorter, being about 0.25 to 0.40 mm. long when fully mature. In dealing with the length of the branchlets, it is to be noted, the hairs are not included.

There are also observed some differences in the stichidia. In *T. perpusillum,* the stichidium has a cylindrical stalk of 3 to 5 segments followed by the broadened, fertile portion of the "blade" composed of varying numbers of 8 to 14 segments (sometimes as few as 4 and sometimes as many as 17) and then a narrower, sterile portion of 6 to 12 segments upon which are the monosiphonous hairs. Sometimes there are also a few sterile segments between the stalk and the fertile segments (pl. 25, fig. 2). In *T. macrourum,* the cylindrical stalk, with only one or two segments, is followed by the broadened, fertile "blade" and then terminates in the hairs, without an intervening sterile portion as in *T. perpusillum* (see text fig. 1b). This difference between the two species is found in the materials examined. However, in a recent communication Dr. Papenfuss remarks that in his material of *T. perpusillum* the tetrasporangia very frequently extend distally up to the hair-forming segments.

The two species, as they are now separated by the writer, also differ from each other in habit. Generally speaking, *T. perpusillum* is more closely and conspicuously fasciculate, the branching often fastigiate and the branchlets usually alternately disposed, whereas in *T. macrourum,* the branchlets are more loosely disposed and usually secund. In the former species, the erect branches are much taller, about 2 to 3 or more millimeters high, and have as many as twelve determinate branchlets. The latter species has

the erect branches about 1 mm. or less high, with generally 4 to 5 determinate branchlets each.

The original description of the genus by Agardh and the subsequent descriptions of others such as Schmitz and Hauptfleisch are far from complete. Many of the important facts about this group of plants, especially with regard to the sexual organs, were discovered much later. It is Thompson (21) to whom we must turn for our present knowledge of the development of the male organs and the general characteristics of the cystocarps; unfortunately there is no detailed account of the developmental phases of these structures. Collins and Hervey (8, p. 117) mentioned that they found a cystocarp which was, however, lost before a drawing and a description could be made.

By bringing together the collections studied by previous authors and studying these in connection with our own, the following revised description of the genus is made possible.

Taenioma J. Agardh (1863). Plants dorsi-ventral, with horizontally creeping, cylindrical, segmented, polysiphonous, ecorticate, main filaments rhizomatous, giving rise to stout, unicellular rhizoids below and erect branches above. Erect branches arising at rather regular intervals, secundly or alternately, pseudodichotomously branched. Determinate branchlets with short, cylindrical, polysiphonous segmented stalks and flattened, segmented, distal portions. The flattened portion with a distinct midrib of a central siphon surrounded by four pericentral siphons. The dorsal and ventral pericentral cells smaller and the lateral ones larger, each giving rise to two marginal cells, which are very regularly, transversely arranged at the periphery. Apical parts of the determinate branchlets provided with colorless, monosiphonous filaments (hairs). Apical cells large, dome-shaped, dividing by transverse walls. Growth monopodial. Branching exogenous. Tetrasporangia originating from lateral pericentral cells, with two rudimentary cover cells, tetrahedrally divided, in two rows, one on each side of the midrib of the fertile branchlets. Spermatangial branchlets flattened, similar to the tetrasporic ones, fertile portions broadened, spermatangia developed upon cells between axial and marginal cells. Cystocarps urceolate with a terminal ostiole, developed from modified branches.

The general habit of members of this genus is like that of *Herposiphonia* of the Rhodomelaceae, with a horizontally creeping filament giving rise to erect branches at rather regular intervals. The division of the apical cells and the mode of growth are similar to the genus *Caloglossa*. The apical cell repeatedly cuts off disc-like cells below until a more or less definite number is reached and then divides by an oblique wall into two unequal parts (pl. 25, fig. 3). The upper part continues as the apical cell of the filament while the lower, dividing by an oblique transverse wall perpendicular to the first, gives rise to another dome-shaped

cell which becomes the apical cell of the new lateral branch. It follows that the branching is strictly lateral, rather than dichotomous as claimed by J. Agardh, although it may appear subdichotomous. Each segment consists at first of a single disc-like cell, which soon gives rise to two cells on the right and left by two longitudinal divisions, thus forming three cells of similar shape and size in the same plane. Then, two other longitudinal divisions occur, parallel to each other, but perpendicular to the first divisions, thus giving rise to two more cells, one dorsally and one ventrally. The segment thus formed is similar to a typical *Polysiphonia* in having a central cell surrounded by four pericentral cells. The segments of the main filaments, the axis of the branches and the stalks of the determinate branchlets always remain this way. In the distal part of the determinate branchlet, however, the two lateral cells each again undergoes two divisions: first an oblique wall cutting off a triangular cell in the upper part and then a second division cuts off a similar cell in the lower part, thus forming two marginal cells of exactly half the height of the pericentral cells.

In the formation of the tetraspores, each of the lateral pericentral cells undergoes a transverse division, the upper cell becoming the sporangium and the lower one the stalk cell. The sporangium enlarges greatly, still always retaining protoplasmic connection with the stalk cell, and, dividing thrice: a longitudinal division parallel to the flat surface, a transverse one and a third perpendicular to both divisions, give rise to a tetrahedrally divided sporangium (pl. 25, fig. 2). The stalk cells eventually form two cover cells on both surfaces.

Falkenberg (10) mentioned and figured what he suspected to be "antheridia." These are now known to be malformations. Schmitz and Hauptfleisch (20) were the first to correctly mention the spermatia as occurring between the midrib and the marginal cells. Their development was reported by Thompson (21) and the writer's investigations substantiate her conclusions. Briefly, the marginal cells are the first to divide longitudinally; the outer ones remain as such while the inner become the spermatangial clusters by repeated divisions. Later, the pericentral cells on both sides of the axial cells also become involved. Thus, in the fertile portion, all of the cells between the marginal cells and the axial ones give rise to spermatangia. Either the entire "blade" or a part of it becomes fertile. The stalk and the apical hairs remain sterile.

Cystocarps, so far, have been described only by Thompson, *op. cit.* The writer has found, in the Bermuda material, a single urceolate, ostiolate cystocarp with rather broad base and conspicuous neck. Being among crowded filaments in a permanent mount, it cannot be studied in detail. According to Thompson, the characteristics of the cystocarps are those of the Rhodomela-

ceae into which family she preferred to place the genus. It seems that further investigations with better materials are necessary in order to solve this problem. But since the vegetative characteristics as well as those of the tetrasporangia and spermatangia show much closer relationships with such plants as *Sarcomenia* and *Caloglossa,* the writer is inclined to follow Falkenberg, Schmitz, and others in placing this genus in the family Delesseriaceae. Papenfuss (MSS) has arrived at this same conclusion as to the taxonomic position of the genus.

As mentioned above, the genus with its two species is reported from various tropical and subtropical regions, although such records are rather meagre. It seems likely that its distribution is very extensive in warmer waters. The two species can readily be distinguished from each other by sterile characters alone:

A. Plants to 2–3 mm. high, flattened determinate branchlets with 15 to 30 segments, apical hairs three .... 1. *T. perpusillum*
AA. Plants less than 1 mm. high, flattened determinate branchlets with 8 to 20 segments, apical hairs two ..... 2. *T. macrourum*

1. Taenioma perpusillum (J. Agardh) J. Agardh, Sp. Alg. 2(3): 1257. 1863. *Polysiphonia perpusilla* J. Agardh, Öfvers. Kgl. Svenska Vetensk.-Akad. Förhandl. 4: 16, 1848. *Taenioma macrourum* Thompson *non* Thuret, Bull. Torrey Bot. Club 37: 97, pl. 9, f. 12, pl. 10. 1910. (In part.)

In a note deposited in the herbarium of the New York Botanical Garden, Howe remarked that the type of this species was mostly sterile, differing considerably in habit from his tetrasporic collection (no. *2433*), but a tetrasporic plant in the type collection was similar. The principal material upon which Thompson based her morphological study of the genus (*Howe 2433*) was growing on a stick of wood collected near low-water mark, at Point Borinquen near Aquadilla, Puerto Rico on June 15, 1903. This material is rich in tetrasporic and spermatangial branchlets; occasionally what seem to be young cystocarps may also be observed.

The Hong Kong materials (*Tseng 2857*) were found tufted on an exposed, surf-beaten rock, together with various small algae, such as *Herposiphonia caespitosa* Tseng, *Gelidium pusillum* (Stackh.) Le Jol., in the lower littoral region at Shek-O, Hong Kong I., on July 4, 1940. They are all tetrasporic. The primary filament is about 90 to 110 μ in diameter, with the segments shorter than the breadth, about 60 to 75 μ long. It sends down vigorous, stout unicellular rhizoids, to as much as 75 μ in diameter, separated from the mother pericentral cells by transverse walls, and more or less expanded at the ends (pl. 25, fig. 1). Erect branches arise from the decumbent filament quite regularly at intervals of 5 to 9 segments. Their axes are cylindrical and segmented like the main filament, giving rise to minor branches or branchlets alternately and fastigiately. The determinate branchlets with cylindrical

stalks below and flattened "blades" above, terminate in three long monosiphonous hairs. The stalks are cylindrical and composed of 3 to 4 segments, about 45 μ in diameter. The blades have conspicuous midribs, to about 70 μ broad when sterile and 0.6 to 1.0 mm. long, generally with 20 to 30 segments. The hairs are about 20 μ in diameter below. The stichidia are very much broadened in their fertile portions, to about 110 μ broad, otherwise like the ordinary branchlets. The tetrahedrally divided tetrasporangia are disposed in two rows along the axis, generally 8 to 14, although fewer or more have been observed. They are about 50 μ in diameter when mature (pl. 25, fig. 2).

A specimen collected by Grunow without giving the date or locality, and another from Tongatabu (Friendly Is.) by Dr. Graeffe all belong here. Heydrich (12) reported that his specimen from Batjan I., North Molucca, had two or three hairs on the stichidia. Most probably, he had this species before him. Askenasy (3) records *T. perpusillum* from Western Australia and Reinbold (18) records it from Sumatra, both without description. In view of the wide occurrence of this species in the Pacific, these identifications are probably correct.

This species, as herein limited, is known from the following regions: St. Augustin, Pacific coast of Mexico (type locality); Fiji and Friendly Is.; Western Australia; Molucca Is.; Sumatra; Hong Kong, China; and Puerto Rico, West Indies.

2. Taenioma macrourum Thuret, in Bornet and Thuret, Not. Alg. 1: 69, pl. 25. 1876. (In part.) *Polysiphonia nana* Kützing, Tab. Phyc. 13: 10, pl. 29, fig. e–f. 1863. *Taenioma perpusillum*, as interpreted by Bornet (6), De Toni (9), Collins and Hervey (8), Børgesen (4), Howe (15), Okamura (17), *non* Agardh.

Since Miss Thompson (21) based her conclusions to a considerable extent upon material collected at West Caicos in the Bahamas (*Howe 5708*) it is of interest to consider the character of these specimens in some detail. The material is tetrasporic with the main filaments generally 60 to 75 μ in diameter and with segments as long as broad. The rhizoids are about 30 μ in diameter. Erect branches are short, less than 1 mm. high, arising in intervals of 4 to 6 segments. They are more loosely and secundly branched than those of the above species. The determinate branchlets have short cylindrical stalks of 1 or 2 segments and "blades" about 60 to 75 μ broad and 240 to 400 μ long (excluding hairs), with 8 to 15 segments and terminating in two colorless, monosiphonous hairs about 25 to 30 μ in diameter at the base. The stichidia are quite young, about 80 to 90 μ broad, with short stalks of 1 to 2 segments, and "blades" having all segments fertile and terminating in two hairs like the vegetative ones.

Another specimen (*Hervey 7433*), collected from South Shore, Bermuda, on February 3, 1913, has vegetative characteristics

similar to the above. There is found, among crowded filaments on a semipermanent mount, a cystocarp which is broadly urceolate, about 360 μ broad and 480 μ long, including a neck about 120 μ long. There is another Bermudian specimen (*Phyc. Bor.-Am. no. 1935*), collected by Hervey, "forming a gelatinous mass with other algae, Bigget Island, April 1913." This, according to Howe (14, p. 518) "shows a small Rhodomelaceous plant bearing some slight resemblance to the *Taenioma*." The writer, however, has found a few fragments of the determinate branchlets of *T. macrourum* Thur. sparsely scattered among a large mass of a blue-green alga and the Rhodomelaceous plant Howe mentioned. They are sterile.

Taenioma macrourum has been recorded from the following regions: Tangier, Morocco (type locality) and Naples in the Mediterranean; Canary Is.; Bermuda and West Indies; Japan; ? Cape of Good Hope.

Summary

A general historical, morphological, taxonomic and distributional survey of the delesseriaceous genus *Taenioma* J. Agardh is given. *T. perpusillum* (J. Agardh) J. Agardh, described from the Pacific coast of Mexico, and *T. macrourum* Thuret, from the Mediterranean, have been regarded, in the past, as belonging to the same species. The conclusion is reached that they represent two distinct species. Important differences are found in the number of apical colorless monosiphonous hairs, the number of segments in the determinate leaf-like branchlets, the stichidia, and the habit and branching of the erect branches. Geographically, both species seem to be widely distributed and are represented, at least in one instance, in the same region (West Indies). A new locality for *T. perpusillum,* namely, Hong Kong on the China coast, is reported.

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Scripps Institution of Oceanography,
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March, 1944.

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REVIEWS

Marine Algae of the Monterey Peninsula. By Gilbert M. Smith. Stanford University Press. vii + 622 pages, 98 plates. 1944. $6.00.

The appearance of a flora in a field in which there are less than half a dozen modern treatises is an event of first importance. Professor Smith has filled one of the outstanding gaps in our knowledge of marine phycology. Since the Monterey flora includes 80 per cent of the known seaweeds of the Pacific Coast of the United States, the importance of the book is much greater than the title suggests. Furthermore this locality is of especial historic interest as the type locality of approximately a quarter of the species described from this coast.

That the northeastern Pacific possesses a rich, varied and in some ways unique seaweed flora has been known for a long time. Setchell and Gardner have given excellent accounts of the Cyano-